

## **06. SORGHUM AND PEARL MILLET - ORIGIN, GEOGRAPHIC DISTRIBUTION, ECONOMIC IMPORTANCE, SOIL AND CLIMATIC REQUIREMENT, VARIETIES, CULTURAL PRACTICES AND YIELD**

### **SORGHUM (*Sorghum bicolor* L.)**

#### **VERNACULAR NAMES**

Juar (Bengali, Gujarati, Hindi), Jola (Kannada), Cholam (Malayalam, Tamil), Jwari (Marathi), Janha (Oriya), Jonnalu (Telugu), Other names: Milo, Chari

#### **ORIGIN**

There are different views about place of origin of sorghum. Warth (1937) was of the opinion that it was originated in India and Africa. De Candolle said that sorghum was originated in Africa. It is believed to originate from North East of Africa or Abyssinia and brought to USA and European countries by slaves.

#### **GEOGRAPHIC DISTRIBUTION**

Sorghum is grown all parts of the world except cool North east part of Europe. Sorghum belts in India receive 400-1000mm rainfall. In the World, Africa (Nigeria, Sudan) is the major continent cultivates sorghum and North America, South America and Asian continents also grow sorghum. In India, mainly on central & peninsular India such as, Maharashtra, Karnataka, MP, AP, Rajasthan, Tamil Nadu and Gujarat are important states cultivating sorghum crop.

#### **ECONOMIC IMPORTANCE**

Sorghum is a cereal grain crop mostly grown in Africa, Asia and Central America, primarily to ease food insecurity. It is the world's fifth largest grain crop and Africa's second most important in terms of tonnage. Sorghum is mostly grown in semi-arid or sub-tropical regions due to its resistance to harsh weather conditions.

Sorghum, a grain, forage or sugar crop is among the most efficient crops in conversion of solar energy and use of water. Sorghum is known as a high-energy, drought tolerant crop. Because of its wide uses and adaptation “sorghum is one of the really indispensable crops” required for the survival of humankind.

In the United States, South America, and Australia sorghum grain is used primarily for livestock feed and in a growing number of ethanol plants. In the livestock market, sorghum is used in the poultry, beef and pork industries. Stems and foliage are used for green chop, hay, silage, and pasture.

#### **CULTURAL PRACTICES**

##### **SEASON AND VARIETIES**

- Thaipattam (January-February), Chithiraipattam (April-May), Adipattam (June-July) and Puratasipattam (September-October) are the four common seasons for sorghum crop in Tamil Nadu.
- The cultivars, CO 26, CO (S) 28, CO (S) 30, BSR 1, COH 4, K tall, K 11, Paiyur 1, Paiyur 2 and APK 1 are most commonly used in Tamil Nadu.

**Selection of seeds:** Good quality seeds are collected from disease and pest-free fields.

**Seed rate:** Irrigated: Transplanted - 7.5 kg/ha; Direct sown - 10 kg/ha  
Rainfed (Direct sown) - 15 kg/ha

Sorghum under irrigated condition is raised both as a direct sown and transplanted crop.

***Advantages of transplanted crop:***

- Main field duration is reduced by 10 days.
- Shoot fly, which attacks direct sown crops during the first 3 weeks and which is difficult to control, can be controlled effectively and economically in the nursery itself.
- Seedlings which show chlorotic and downy mildew symptoms can be eliminated, thereby incidence of downy mildew in the main field can be minimised.
- Optimum population can be maintained as only healthy seedlings are used for transplanting.
- Seed rate can also be reduced by 2.5 kg/ha.

**NURSERY PRACTICES FOR TRANSPLANTED SORGHUM**

**Nursery preparation**

For raising seedlings to plant one hectare, select 7.5 cents (300 m<sup>2</sup>) near a water source where water will not stagnate.

**Application of FYM to the nursery**

- Apply 750 kg of FYM or compost and apply another 500 kg of compost or FYM for covering the seeds after sowing.
- Spread the manure evenly on the un-ploughed soil and incorporate by ploughing or apply just before last ploughing.

**Laying the nursery**

- Provide three separate units of size 2 m x 1.5 m with 30 cm space in between the plots and all around the unit for irrigation.
- Excavate the soil from the inter-space and all around to a depth of 15 cm to form channels and spread the soil removed on the bed and level.

**Pre-treatment of seeds**

- Treat the seeds 24 hours prior to sowing with Carbendazim or Captan or Thiram at 2g/kg of seed.
- Treat the seeds with three packets (600 g)/ha of *Azospirillum* and 3 packets (600g) of phosphobacteria or 6 packets of Azophos (1200g) using rice gruel as binder.

**Sowing and covering the seeds**

- Make shallow rills, not deeper than 1cm on the bed by passing the fingers vertically over it.
- Broadcast 7.5 kg of treated seeds evenly on the beds.
- Cover by leveling the rills by passing the hand lightly over the soil.

**Water management**

- Provide one inlet to each nursery unit.
- Allow water to enter through the inlet and cover all the channels till the raised beds are wet and then cut off water
- Adjust the frequency of irrigation according to the soil types. If it is red soils, at 4-5 days interval and black soils, 5-6 days interval is to be maintained.

NOTE: Do not keep the seedlings in the nursery for more than 18 days. If older seedlings are used, establishment and yield are adversely affected. Do not allow cracks to develop in the nursery by properly adjusting the quantity of irrigation water.

## **B. MAIN FIELD PREPARATION**

### **Ploughing**

- Plough the field with an iron plough once (or) twice. Sorghum does not require fine tilth since fine tilth adversely affects germination and yield in the case of direct sown crop.
- To overcome the subsoil hard pan in *Alfisols* (deep red soils) chiseling the field at 0.5m intervals to a depth of 40 cm on both the directions of the field followed by disc ploughing once and cultivator ploughing twice help to increase the yield of sorghum and the succeeding blackgram also. This was true with Sorghum followed by Groundnut also.
- Application of FYM and 100% of recommended N can also be followed. In soils with subsoil hard pan, chiselling should be done every year at the start of the cropping sequence to create a favourable physical environment.

### **Application of FYM**

Spread 12.5 t/ha FYM or composted coir pith along with 10 packets of *Azospirillum* (2000g/ha) and 10 packets (2000 g/ha) of phosphobacteria or 20 packets of Azophos (4000g/ha) on the unploughed field and incorporate the manure in the soil. Apply well decomposed poultry manure @ 5 t/ha to improve the grain yield as well as physical properties of soils.

### **Formation of ridges and furrows**

- Form ridges and furrows using a ridger at 6 m long and 45 cm apart.
- Form irrigation channels across the furrows.
- Alternatively, form beds of size 10 m<sup>2</sup> and 20 m<sup>2</sup> depending on the availability of water.

### **Application of fertilizers**

#### **Transplanted crop**

- Apply NPK fertilizers as per soil test recommendations. If soil test recommendations are not available, adopt a blanket recommendation of 90 N, 45 P<sub>2</sub>O<sub>5</sub>, 45 K<sub>2</sub>O kg/ha.
- Apply N @ 50:25:25% at basal, 15 and 30 DAS and full dose of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O basally before planting.
- In the case of ridge planted crop, open a furrow 5cm deep on the side of the ridge at two thirds the distance from the top of the ridge and place the fertilizer mixture along the furrow and cover with soil up to 2 cm.
- Soil application of *Azospirillum* at 10 packets (2 kg/ha) and 10 packets (2000g/ha) of phosphobacteria or 20 packets of Azophos (4000g/ha) after mixing with 25 kg of FYM + 25 kg of soil may be carried out before sowing/planting.

#### **Direct sown crop**

- As above.
- In the case of sorghum raised as a mixed crop with a pulse crop (Blackgram, Greengram or Cowpea) open furrows 30 cm apart to a depth of 5 cm.
- Apply fertilizer mixture in two lines in which sorghum is to be raised and cover upto 2 cm.
- Skip the third row in which the pulse crop is to be raised and place fertilizer mixture in the next two rows and cover upto 2 cm with soil.
- When *Azospirillum* is used, apply only 75% of recommended N for irrigated sorghum.

### **Application of micronutrient mixture**

#### **Transplanted crop**

- Mix 12.5 kg/ha of micronutrient mixture formulated by the Department of Agriculture, Tamil Nadu with enough sand to make a total quantity of 50 kg and apply the mixture over the furrows and on top one third of the ridges.
- If micronutrient mixture is not available, mix 25 kg of zinc sulphate with sand to make a total quantity of 50 kg and apply on the furrows and on the top one third of the ridges.

#### **Direct sown crop**

- As above.
- Basal application of FeSO<sub>4</sub>, 50 kg/ha along with 12.5 t/ha FYM for iron deficient soils.

#### **Sowing / Transplanting sorghum**

##### **Transplanted crop**

- Pull out the seedlings when the seedlings are 15 to 18 days old.
- Prepare slurry with 5 packets of *Azospirillum* (1000g/ha) and 5 packets (1000g/ha) of Phosphobacteria or 10 packets of Azophos (2000 g/ha) in 40 lit. of water and dip the root portion of the seedlings in the solution for 15-30 minutes and transplant.
- Plant one seedling per hill
- Plant the seedlings at a depth of 3 to 5 cm.
- Plant the seedlings on the side of the ridge, half the distance from the top of the ridge and the bottom.
- Maintain a spacing of 15 cm between plants in the row which are 45 cm apart (15 plants/m<sup>2</sup>).

##### **Direct sown crop**

- In the case of pure crop of sorghum, maintain the seed rate at 10kg/ha.
- In the case of inter crop of sorghum with pulse crop, maintain the seed rate of sorghum at 10 kg/ha and pulse crop at 10 kg/ha.
- In the case of pure crop of sorghum, sow the seeds with a spacing of 15 cm between seeds in the rows which are 45 cm apart.
- Maintain one plant per hill.
- If shootfly attack is there, remove the side shots and retain one healthy shoot.
- Sow the seeds over the lines where fertilizers are placed.
- Sow the seeds at a depth of 2 cm and cover with soil.
- In the case of sorghum intercropped with pulses, sow one paired row of sorghum alternated with a single row of pulses. The spacing between the row of sorghum and pulse crop is 30 cm.
- Forage cowpea CO 1 can be inter-cropped in sorghum at two rows of fodder cowpea in between paired rows of sorghum.

#### **Weed management**

- Apply the pre-emergence herbicide Atrazine 50 WP @500 g/ha on 3 days after sowing as spray on the soil surface, using Backpack / Knapsack / Rocker sprayer fitted with a flat fan nozzle using 900 litres of water/ha.
- Sorghum is slow growing in early stages and is adversely affected by weed competition. Therefore keep the field free of weeds up to 45 days. For this, after pre-emergence herbicide application, one hand weeding on 30-35 days after sowing may be given.
- If pulse crop is to be raised as an inter-crop in sorghum do not use Atrazine.

- Hoe and hand weed on the 10<sup>th</sup> day of transplanting if herbicides are not used. Hoe and weed between 30-35 days after transplanting and between 35-40 days for a direct sown crop, if necessary.

### **Thinning of the seedlings and gap filling**

Thin the seedlings and gap fill with the seedlings thinned out. Maintain a spacing of 15 cm between plants after the first hand weeding on the 23<sup>rd</sup> day of sowing. Thin the pulse crop to a spacing of 10 cm between plants for all pulse crop except cowpea, for which spacing is maintained at 20 cm between plants.

### **Water management**

Usually sorghum is raised as rainfed crop. The irrigation should, however, be provided whenever, rains are not received. At the time of flowering and grain filling stages, the crop requires more water. If enough moisture is not there in the soil at the time of flowering and grain filling stages, it should be irrigated at once. At no stage, the plants should be allowed to wilt. Suitable drainage conditions should be provided for the removal of excess rain water from the field. About 400mm of water is required to raise grain sorghum crop.

**NOTE :** Adjust irrigation schedule according to the weather conditions and depending upon the receipt of rains.

Contingent plan: This should be done before 75% of soil moisture is lost from available water. Spraying 3% Kaolin (30 g in one litre of water) during periods of stress will mitigate the ill effects.

### **Harvesting and processing**

- Consider the average duration of the crop and observe the crop. When the crop matures the leaves turn yellow and present a dried up appearance.
- The grains are hard and firm. At this stage, harvest the crop by cutting the earheads separately. Cut the straw after a week, allow it to dry and then stack. In the case of tall varieties, cut the stem at 10 to 15 cm above ground level and afterwards separate the earheads and stack the straw. Dry the earheads. Thresh using a mechanical thresher or by drawing a stone roller over the earheads or by using cattle and dry the produce and store.

## **RAINFED SORGHUM**

**Rainfall:** Average and well distributed rainfall of 250-300 mm is optimum for rainfed sorghum.

### **Distribution**

Rainfed sorghum is cultivated in Madurai, Dindigul, Theni, Ramanathapuram, Tirunelveli, Thoothukudi, Virudhunagar, Sivagangai, Tiruchirapalli, Erode, Salem, Namakkal, Coimbatore and Dharmapuri districts of Tamil Nadu.

### **Season**

The crop can be grown in South west and North east monsoon seasons provided, the rainfall is evenly distributed.

### **Field preparation**

- As above
- To conserve the soil moisture sow the seeds in flat beds and form furrows between crop rows during inter cultivation or during third week after sowing.

**Seed rate:** 15 kg/ha

### Seed treatment

- Seed hardening ensures high germination. The seeds are pre-soaked in 2% potassium dihydrogen phosphate solution for 6 hours in equal volume and then dried back to its original moisture content in shade and are used for sowing.
- Harden the seeds with 1% aqueous fresh leaf extract of *Prosopis juliflora* and pungam, (*Pongamia pinnata*) mixed in 1:1 for 16 hrs at 1:0.6 ratio (Seed and solution) followed by drying and subsequently pelleting the seeds with Pungam leaf powder @300 g/kg with gruel.
- Soak the seeds in 500 ppm of CCC (500 mg in one litre of water) for six hours and shade dry the seeds for 5 hours. Use 350 ml of solution for soaking one kg of seed.
- Treat the seeds with three packets of *Azospirillum* (600 g) and 3 packets of phosphobacteria or 6 packets of Azophos (1200 g/ha). In the main field, apply 10 packets of *Azospirillum* 2000 g/ha and 10 packets (2000g/ha) of phosphobacteria or 20 packets of Azophos (4000 g/ha) with phosphobacteria 2 kg with 25 kg FYM + 25 kg soil.

### Pre-monsoon sowing

Sow the hardened seeds at 5 cm depth with seed cum fertilizer drill to ensure uniform depth of sowing and fertilizer application before the onset of monsoon as detailed below:

District	Optimum period
1. Coimbatore	37-38 <sup>th</sup> week (II to III week of September)
2. Erode	38 <sup>th</sup> week (III week of September)
3. Sivaganga	40 <sup>th</sup> week (I week of October)
4. Ramanathapuram	40 <sup>th</sup> week (I week of October)
5. Thoothukudi	39-40 <sup>th</sup> week (Last week of September to I week of October)
6. Vellore, Tiruvannamalai	37-38 <sup>th</sup> week (September II week to September III week)

### Sowing

Sow the seeds well before the onset of monsoon at 5 cm depth (by seed drill or by country plough). The seed is pelleted with 15 g of Chloropyriphos in 150 ml of gum and shade dried.

- Sow the sorghum seeds over the line where the fertilizers are placed.
- Sow the seeds at a depth of 5 cm and cover with the soil.
- Sow the seeds with the spacings of 15 cm in the paired rows spaced 60 cm apart.
- Sow the pulse seeds to fall 10 cm apart in the furrows between the paired rows of sorghum.

**Spacing:** 45 x 15 cm or 45 x 10 cm.

### Fertilizer application

Apply 12.5 t/ha of Composted coir pith + NPK at 40:20:0; Apply enriched FYM 750 kg/ha. The recommended dose of 40 kg N and 20 kg P<sub>2</sub>O<sub>5</sub>/ha for rainfed sorghum can be halved if FYM @ 5 t/ha is applied.

### Weed management

Keep sorghum field free of weeds from second week after germination till 5<sup>th</sup> week. If sufficient moisture is available spray Atrazine @ 500 g/ha as pre-emergence application within 3 days after the receipt of the soaking rainfall for sole sorghum while for sorghum based intercropping system with pulses, use Pendimethalin at 3.0 l/ha.

### Cropping system

- The most profitable and remunerative sorghum based cropping system adopted is sorghum with cowpea, redgram, lab-lab, blackgram.
- In rainfed *Vertisol*, adopt paired row planting in sorghum and sow one row of blackgram/cowpea in between paired rows of sorghum to have 100% population of sorghum plus 33% population of blackgram/cowpea.
- Intercropping of sunflower CO 1, with the main crop of sorghum CO 26 in 4:2 ratio is recommended under rainfed conditions during North-East monsoon for black soils of Coimbatore.
- Intercropping of soybean with sorghum in the ratio 4:2 is recommended for kharif seasons.
- Tamarind and Neem trees upto 3-4 years from date of planting form an ideal tree component for agroforestry in black cotton soils of Kovilpatti. Sorghum and blackgram gave higher yield even at 50% of the recommended level of fertilizer application

### **RATOON SORGHUM CROP**

#### **Ratooning technique**

- Harvest the main crop leaving 15 cm stubbles.
- Remove the first formed two sprouts from the main crop and allow only the later formed two sprouts to grow. Allow two tillers per hill.

#### **Hoing and weeding**

- Remove the weeds immediately after harvest of the main crop.
- Hoe and weed twice on 15<sup>th</sup> and 30<sup>th</sup> day after cutting.

#### **Application of fertilizers**

- Apply 100 kg N/ha in two split doses.
- Apply the first dose on 15<sup>th</sup> day after cutting and the second on 45<sup>th</sup> day after cutting. Apply 50 kg P<sub>2</sub>O<sub>5</sub>/ha along with the application of N on 45<sup>th</sup> day.

#### **Water management**

- Irrigate immediately after cutting the main crop.
- Irrigation should not be delayed for more than 24 hours after cutting.
- Irrigate on 3<sup>rd</sup> or 4<sup>th</sup> day after cutting. Subsequently irrigate once in 7-10 days.
- Stop irrigation on 70-80 days after ratooning.

#### **Harvest**

- Harvest the crop when the grains turn yellow.

NOTE: The duration of the ratoon crop is about 15 days less than the main crop.

#### **Yield**

Grain yield of 4.0–6.0 tonnes and fodder yield of 15-20 tonnes can be obtained under irrigated condition. In rainfed areas, 50-60% of grain yield and 60-80% of fodder yield can be made possible depending on the rainfall prevailed. Under ratoon condition, mainly sorghum is raised for fodder purpose and about 15 tonnes of fodder yield can be obtained.

### **PEARL MILLET (*Pennisetum glaucum* (L) R. Br.)**

#### **VERNACULAR NAMES**

Bajra (Bengali, Hindi, Oriya), Bajri (Gujarati, Marathi), Sajje (Kannada), Bajr'u (Kashmiri), Cambu (Malayalam, Tamil), Sazzalu (Telugu). Other names: Spiked millet, Pearl millet

#### **ORIGIN**

Most of the scientists believe that the primary centre of origin of pearl millet is Africa from where it spread to India. In study of the variability of a large number of strains of pearl millet from Africa and India, the greatest range of variability was found in the strains from Africa. This is further evidence of the African origin of pearl millet.

## **GEOGRAPHIC DISTRIBUTION**

Pearl millet is a crop grown mostly in tropical climate. It is widely grown in Africa and Asia. The important pearl millet growing countries are India, China, Nigeria, Pakistan, Sudan, Egypt, Arabia and Russia. In India pearl millet is grown in almost everywhere except in high rainfall areas like Assam, West Bengal and Odisha. States of Rajasthan, Maharashtra, Gujarat, UP, Haryana accounts 87% of total area.

## **ECONOMIC IMPORTANCE**

Pearl millet is one of the major coarse grain crops and is considered to be a poor man's food. It is staple food in a short period in the relatively dry tracts of the country. It is the most drought tolerant crop among cereals and millets. The grain of pearl millet is superior in nutritive value to sorghum grain but inferior in feeding value. Grain contains 12.4% of moisture, 11.6% of protein, 5% of fat, 67% of carbohydrates and 2.7% of minerals. Pearl millet grains are eaten cooked like rice or 'chapatis' are prepared. It is also used as feed for poultry industry and green fodder or dry fodder for cattle.

## **CULTIVATION PRACTICES**

### **Season and varieties**

Chithirapattam (March-April) and Masipattam (January-February) are the two most common seasons of pearl millet. Pearl millet is cultivated throughout the state except the Nilgris. CO 7, CO (Cu) 9, X 7, ICMV 221 are important cultivars of pearl millet in Tamil Nadu.

### **A. NURSERY**

#### **Preparation of land**

- For raising seedlings to plant one ha select 7.5 cents near a water source. Water should not stagnate.
- Plough the land and bring it to the fine tilth.

#### **Application of FYM**

Apply 750 kg of FYM or compost and incorporate by ploughing. Cover the seeds with 500 kg of FYM.

#### **Forming raised bed**

- In each cent mark 6 plots of the size 3 m x 1.5 m with 30 cm channel in between the plots and all around.
- Form the channel to a depth of 15 cm.
- Spread the earth excavated from the channel on the beds and level.

NOTE: The Unit of 6 plots in one cent will form one unit for irrigation.

#### **Removal of ergot affected seeds and *Sclerotia* to prevent primary infection**

- Dissolve one kg of common salt in 10 litres of water.
- Drop the seeds into the salt solution
- Remove the ergot and sclerotia affected seeds which will float.

- Wash seeds in fresh water 2 or 3 times to remove the salt on the seeds.
- Dry the seeds in shade.

Treat the seeds with three packets (600g) of the *Azospirillum* inoculant and 3 packets (600g) of phosphobacteria or 6 packets (1200g) of Azophos.

### **Treatment of the nursery bed with insecticides**

Apply phorate 10 G 180 g or Carbofuran 3 G 600 g mixed with 2 kg of moist sand, spread on the beds and work into the top 2 cm of soil to protect the seedlings from shoot fly infestation.

### **Sowing and covering the seeds**

- Open small rills not deeper than 1 cm on the bed by passing the fingers over it.
- Sow 3.75 kg of seeds in 7.5 cents (0.5 kg /cent) and use increased seed rate up to 12.5 kg per ha in shootfly endemic area and transplant only healthy seedlings.
- Cover the seeds by smoothening out the rills with hand. Sprinkle 500 kg of FYM or compost evenly and cover the seeds completely with hands

NOTE: Do not sow the seeds deep as germination will be affected.

### **Irrigation to the seed bed**

- Provide one inlet to each unit of 6 plots to allow water in the channels.
- Allow water to enter the channel and rise up in it. Turn off the water when the raised bed is wet.

Note: The seedlings should not be kept in nursery for more than 18 days. Otherwise the establishment and yield will be affected adversely. Ensure that cracks should not develop in the nursery. This can be avoided by properly adjusting the quantity of irrigation water.

## **B. MAIN FIELD**

### **Field preparation**

- Plough with an iron plough twice and with country plough twice. Bring the soil into fine tilth.
- **Chiseling for soils with hard pan:** Chisel the soils having hard pan formation at shallow depths with chisel plough at 0.5m interval, first in one direction then in the direction perpendicular to the previous one, once in three years.

### **Application of FYM or compost**

Spread 12.5 t/ha of FYM or compost or composted coir pith uniformly on unploughed soil. incorporate the manure by working the country plough and apply *Azospirillum* to the soil @ 10 packets per ha (2000 g) and 10 packets (2000g) of phosphobacteria (or) 20 packets (4000g) of azophos with 25kg of soil and 25 kg of FYM.

### **Forming ridges and furrows/beds**

- Form ridges and furrows (using 3 ridges) 6 m long and 45 cm apart. If pulses is intercropped, form ridges and furrows 6 m long and 30 cm apart.
- If ridge planting is not followed, form beds of the size 10 m<sup>2</sup> or 30 m<sup>2</sup> depending upon water availability.
- Form irrigation channels.

- To conserve soil moisture under rainfed condition, sow the seeds in flat and form furrows between crop rows during inter cultivation on third week after sowing.

### **Application of fertilizers**

Apply NPK fertilizers as per soil test recommendations as far as possible. If soil test recommendation is not available follow the blanket recommendation of 70:35:35 kg N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O/ha for all varieties. For hybrids, apply 80 kg N, 40 kg P<sub>2</sub>O<sub>5</sub> and 40 kg K<sub>2</sub>O/ha. Apply the recommended N in three splits as 25:50:25 per cent at basal, 15 and 30 DAS and full dose of phosphorus and potassium basally. Combined application of *Azospirillum* and phosphobacteria or Azophos along with 75 per cent of the recommended level of N and P is recommended for rainfed conditions.

**Method of application:** For transplanted crop, open a furrow more than 5 cm deep on the side of the ridge (1/3 distance from the bottom), place the fertilizer and cover. For the direct sown crop, mark the lines more than 5 cm deep 45 cm apart in the beds. Place the fertilizer below 5 cm depth and cover up to 2 cm from the top before sowing. In the case of intercropping with pulses, mark lines more than 5 cm deep 30 cm apart in the beds. Apply fertilizer only in the rows in which pearl millet is to be sown and cover up to 2 cm. When *Azospirillum* inoculant is used for seeds, seedlings use only 50 kg N/ha for variety, 60 kg N/ha for hybrid, as soil application in other words, reduce 25% N of soil test recommendations.

### **Application of micronutrient mixture**

Apply 12.5 kg/ha of micronutrient mixture formulated by the Department of Agriculture. Mix the mixture with enough sand to make 50 kg and apply on the surface just before planting/after sowing and cover the seeds. Broadcast the mixture on the surface to seed line. If micronutrient mixture is not available apply 25 kg of zinc sulphate per ha. Mix the chemical with enough sand to make 50 kg and apply as above.

## **MANAGEMENT OF MAIN FIELD**

### **Transplanted crop**

- Pull out the seedlings when they are 15 to 18 days old.
- Adopt the spacing 45 x 15 cm for all the varieties.
- Plant seedlings on the side of ridge, half way from the bottom. Depth of planting should be 3 to 5 cm.
- Root dipping with bio-fertilizers: Prepare the slurry with 5 packets (1000 g)/ha of *Azospirillum* inoculant and 5 packets (1000g/ha) of phosphobacteria or 10 packets of Azophos (2000g/ha) in 40 lit. of water and dip the roots of the seedlings 15-30 minutes before planting.

### **Direct sown crop**

- Soaking of pearl millet seeds either in 2% Potassium chloride (KCl) or 3% Sodium Chloride (NaCl) for 16 hours followed by 5 hours shade drying improves germination and stand.
- Adopt the spacing of 45 x 15 cm for all varieties. If pulse is intercropped, adopt a spacing of 30 x 15 cm for pearl millet and 30 x 10 cm for pulses. One pair row of pearl millet is alternated with a single row of pulse crop.
- In the furrows in which fertilizers have been applied, place 5 kg of seed, allowing them to fall 4-5 cm apart (Use higher seed rate of 5 kg to offset mortality). The optimum population

should be 1, 45,000 per ha. Use increased seed rate up to 12.5 kg per hectare in shoot fly endemic area and remove the shoot fly damaged seedlings at the time of thinning.

- Where pulse seeds are to be sown, drop pulse seeds to fall 5 cm apart and cover.

### **Weed management**

- Apply the pre-emergence herbicide Atrazine 50 WP @ 500 g/ha, 3 days after sowing or transplanting as spray on the soil surface using Back-pack/Knapsack/Rocker sprayer fitted with flat type nozzle using 900 l of water/ha.
- Apply herbicide when there is sufficient moisture in the soil.
- Hand weed on 30 - 35 days after sowing if pre-emergence herbicide is applied.
- If pre-emergence herbicide is not applied hand weed twice on 15 and 30 days after sowing.

### **Thinning and gap filling**

In direct sown crop after 1st weeding at the time of irrigation, gap fill and thin the crop to a spacing of 15 cm between plants; cowpea crop to 20 cm between plants and other pulses crops to 10 cm between plants.

### **Top dressing of fertilizers**

- Top dress the nitrogen at 15 and 30 days after transplanting or direct sowing.
- In transplanted crop, open a furrow 5 cm deep with a stick or hoe at the bottom of the furrow, place the fertilizer and cover.
- In the case of direct sown crop apply the fertilizer in band. If intercropped with pulses apply the fertilizer to pearl millet crop only.
- After the application of fertilizer, irrigate the crop.

### **Water management**

It is highly drought tolerant and hence, 2-3 irrigations are sufficient. Flowering and grain filling are the critical stages and about 300-400mm of water is sufficient to complete its life cycle.

NOTE: Irrigation schedule is to be adjusted depending upon the prevailing weather conditions.

### **Harvesting the crop**

**Symptoms of maturity:** Leaves will turn yellow and present a dried appearance. Grains will be hardened.

**Harvesting:** Cut the earheads separately. Cut the straw after a week, allowing it to dry and stack it in the field till it can be transported.

### **Threshing, cleaning, drying and storing**

Dry the earheads. Thresh in a mechanical thresher or spread it and drag a stone roller over it or cattle threshes. Dry the seeds below 10 per cent and mix 100 kg of grains with 1kg of activated kaolin to reduce the rice weevil and rice moth incidence. Spray Malathion 50EC 10 ml/ lit @ 3 lit of spray fluid/100 m<sup>2</sup> over the bags during storage godowns, For grain purpose the grain should be dried well below 10% moisture and stored in gunny bags.